

THE FORMATION OF CHINESE MULTI-WORD CONSTRUCTIONS:
EVIDENCE FROM THE PROCESSING AND PRODUCTION OF
CHINESE NATIVE SPEAKERS

BY

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THESIS

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ABSTRACT

In this thesis, the formations of two multi-word constructions in Chinese—the V-O verb copy constructions (VCC) and the disyllabic root-compound words (DSC)—are re-examined based on the evidence from native speakers’ processing and production. The purpose of this study is to fill an empirical gap from the perspective of theoretical postulations for the two constructions, namely, the Copy Merge Theory of Movement under the generative framework, and the ‘pre-stored templates’ and ‘emergence model’ assumed by the constructionist framework. Different from previous studies, the experimental approach is used as an alternative approach in my thesis. In examining the VCCs, a fill-in-the-blank task elicited native speakers’ responses to two blank conditions of the VCC context; a self-paced reading task compared native speakers’ reaction times to the VCC and non-VCC chunks of controlled frequencies. The overall findings confirm that native speakers perceive the VCCs the same way as they are derived according to the syntactic operations; the results also reveal that there may be a length constraint for the productivity of the ‘pre-stored templates’. In the investigation of the headedness structures of the DSCs, native speakers’ coinages were elicited and compared to the generalizations drawn on the basis of the textual materials. The results reveal that headed forms (as opposed to non-headed forms) are the prevalent structures in Chinese language as well as in Chinese speakers’ mental representations. This finding supports the language acquisition model put forward by emergent grammar, which assumes a correlation between inputs and outputs.

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Introduction

Language units of varying sizes—morphemes, single words, phrases and sentences—can be categorized by the nature of their formation. For instance, single words are built by morphemes in certain hierarchies and, sentences are constructed by words in designated orders. No matter what size the unit is, its formation, in most cases, is not random but follows rules. Universal Grammar (UG) proposes that language expressions are generated by recursive rules contained in the human brain in spite of the ‘poverty of the stimulus’ (Chomsky, 1965). Construction Grammar (CG) assumes that language acquisition starts from storing individual instances in the mental lexicon; then gradually, language users abstract away from these concrete instances a set of schemas, following which novel expressions are coined (Fillmore et al., 1988; Langacker, 1987; Goldberg, 1995; Bybee, 2006). Despite different proposals for the foundation of language acquisition, one common ground of the two theories is that language expressions are highly regulated. Starting from this point, regulative or derivative principles and hypotheses in the domain of morphology and syntax are put forward for constructions on the word level and sentence level, respectively.

Nevertheless, less attention is paid to units beyond single-word but smaller than the sentence stage, namely, multi-word constructions (MWC). One reason is that multi-word constructions are not always constituents; some of them are linear word streams crossing syntactic phase. Another reason is that these constructions usually bear conventionality in terms of form-meaning patterning. In other words, MWCs do not fit in any particular categorization because their formation may not follow the basic regulations of any domain, nor are their properties completely derivable from base forms.

However, the MWCs can also be highly productive. Due to this fact, sub-principles are attempted to accommodate the MWCs under a theoretical framework. This line of analysis focuses on capturing the morpho-syntactic distributions of the MWCs in order to generalize the rules that language users follow when coining new MWCs or predicting the meaning of a new MWC. The ultimate goal of these analyses is to provide an account for the acquisition of the less regular forms. Also, for that matter, the properties of the MWCs need to be observed and deduced from natural language productions. In turn, the postulated regulations can be validated by native speakers' intuitions, which reflect the mental representation of these linguistic materials.

In this study, experimental approaches are utilized, aiming to examine the formations of two Chinese MWCs through evidence from the processing and productions by Chinese L1 users of these constructions. One purpose is to test the existing hypotheses proposed by two major language models—generative models (Nunes, 1999, 2004; Kayne, 1994; Huang, 2005; Cheng, 2007) and constructionist models (Bybee, 1998; Goldberg, 1995; Booij, 2009; Tomasello, 2003). The other purpose is to address the undecided issues concerning the morpho-syntactic properties of these Chinese MWCs: to the VCCs, how do we determine the identification/part of speech of these word bundles since Chinese language lacks inflectional morphology; to the DSCs, where is the canonical center and what is the inner structure of these two-word forms?

This thesis is organized as follows: Chapter I deals with the Chinese V-O verb copy constructions. In this part, a fill-in-the-blank task and a self-paced reading task were conducted to test the derivational and constructional hypotheses for the construction. Chapter II investigates the internal structural hierarchy of disyllabic root-compounding

words. Debates about the head positions of these shortest yet major MWCs were re-examined. The findings from two elicited production tasks were compared with the findings based on the analysis of textual materials. Finally, a summary of those findings and the limitation of the current work are presented in Chapter III.

Chapter I The processing of Chinese V-O verb copy constructions by L1 speakers

In this chapter, two experiments examined the identification and processing of the V-O sequences in the context of verb copy constructions (VCC) in Chinese by native speakers (NSs). The construction of interest is Subject + V_H + Object + V_L + *le* + durative Phrase (dP), such as 他骑马骑了三个小时 *tā-q ímǎ-q íle-sāngè xiǎoshí* he-ride-horse-ride-*le*-three hours ‘he rode horses for three hours’. Two critical parts of the sentence are: 1) the V-O-V sequence 骑马骑 *q ímǎ-q íride-horse-ride*, which contains two verb copies, a higher one (V_H) and a lower¹ one (V_L), of the same verb 骑 *q í* ‘to ride’, and 2) its inner V-O 骑马 *q ímǎ* ride-horse, which forms a verb argument structure by itself.

Different theoretical analyses under generative and constructionist frameworks attempt to derive VCCs and their inner V-O sequences. One claim proposed by the Lexical Integrity Principle (LIH) under generative framework is that the V-Os function like compound words and participate in syntactic operations holistically, so the V inside the V-O sequence does not alone interact with any other parts of the sentence. Chinese syntax and morphology both have V-O combinations in their domains, realized as a verbal phrase and a compound word, respectively. Given that Chinese does not have inflecting morphology, the identity of a V-O sequence usually only can be told by the distinguishing syntactic distributions. In the VCC context, the slot that the V-O sequence occupies is typically a predicate slot, so the V-O should be considered as a verbal phrase. But the intuitive judgement is complicated by the presence of another verb after the V-O

¹ In this study, ‘lower’ indicates a position towards the right-hand of the construction, ‘higher’ towards the left-hand of the construction.

sequence and immediately preceding the aspectual *le*. The aspectual marker *le* in Chinese is a verb suffix allowed to attach to the main verb of a sentence as in 我吃了饭 wǒ-chī-le-fàn I-eat-rice-*le* 'I have eaten', or to the whole verbal phrase, as in a simplex sentence 我吃饭了 wǒ-chī-fàn-le I-eat-rice-*le* 'I have eaten'. If following the *le* rule and the V-O in the VCC context being considered as a verbal phrase, the *le* should also be allowed after the V-O, forming a V-O-*le*-V sequence, which is not the case. On the opposite, the Construction Grammar (CG) proposes that the V-O-V sequence is not decomposable or analyzable by the regular rules in the Universal Grammar (UG) because the VCC is a pre-fabricated and pre-stored temple in the mental lexicon, which is specifically used to produce the complex predicates VOV; therefore the two Vs in a VOV sequence are pre-linked by default and not separable. As a result, CG does not have any arguments for the inner V-O sequences. On the other hand, the Construction Morphology (CM), which is also under constructionist framework but deals with complex word formation, argues that compound words such as V-O compounds may also be pre-listed instances in the mental lexicon, either because of their idiosyncrasy or because of their high frequencies. This proposal may lead to the claim that there is possibility that the inner V-O of a VCC sequence would be considered as a separate compound word if its usage frequency is very high and the high frequency makes the V-O sequence more salient and familiar to NSs because it is pre-listed in people's mental inventories. But overall, constructionist approaches assume that MWCs can also be formed in the mental lexicon as opposed to generative approaches, which assume the MWCs are online derived by syntactic operations.

In this study, we take a reductionist view, aiming to find evidence from language productions and processing regarding how NSs would perceive the V-O and the VCC. In a timed fill-in-the-blank task, elicited responses in two blank conditions—one with the V_H missing, the other with the V_L missing—were compared. The results show that (1) the missing V_H yielded a greater number of copy responses, suggesting the derivation of the V_H more is dependent on the processing of the V_L , and (2) the missing V_L elicited a greater number of non-copy responses, indicating that the derivation of the V_L may be independent of the processing of the V_H , suggesting that V_H -O is likely to be interpreted separately from the rest of the VCC. In addition, in a self-paced reading task, the VCC was divided into two sequences: V_H and O- V_L ; the V_L was manipulated and the response times of the O- V_L chunks were compared. We found that the O- V_L -COPY sequence was processed faster than the O- V_L -NONCOPY sequence, in spite of the fact that V_L -NONCOPY and the preceding object had higher probability of co-occurrence in the corpus than its V_L -COPY counterpart. The results demonstrate that the dependency between V_H and V_L functions as a stronger prime than the collocation frequency between V_L and O. The overall findings are consistent with the derivational analyses, which interface syntax and the lexicon: although VCC may be a pre-stored construction, the processing of the VCC may be layered rather than flat, with the architecture of VO-V with the V-O sequence being perceived as a relatively independent entity.

This chapter is organized as follows. 1.1 provides analyses of different theoretical approaches and assesses their applicability in solving the multi-word sequence VCC in Chinese. Section 1.2 and 1.3 reports two experiments examining the identification and processing of the structure in question in order to examine different theories presented in

2.1. Finally, Section 1.4 presents a general discussion about the interaction between syntax and lexicon, in the context of the experimental findings.

1.1 Theoretical analyses in different frameworks

Chinese verb-copy constructions (VCC) contain two copies of the same verb with the higher copy always taking the object and the lower copy always taking Extent Phrases² (EXT, see 1a) or aspectual information (ASP, see 1b).

- (1) a. 李四骑马骑得很累。

Lǐsì qí mǎ qí de hěn lǎi

Lisa ride horse ride EXT very tired

‘Lisa rode horses to the extent that he got tired /

Lisa got tired by riding a horse.’

- b. 李四骑马骑了三个小时。

Lǐsì qí mǎ qí le sān-gè xiǎoshí

Lisa ride horse ride ASP three-CLASS hours

‘Lisa rode horses for three hours /

Lisa did a horse-riding for three hours.’

One observation of the contrast between the English glosses and the Chinese sentences is that, in Chinese sentences, no inflecting morphemes such as past tense suffix (-ed) or gerund nominal ending (ing) could be utilized to determine the identity of the V-O 骑马 qí mǎ ride-horse. The universal grammarians want to make clear the identity of the V-O partially because it is related to the semantic interpretation of the structure. Specifically, it is difficult to determine whether the V-O sequence should be better

² Extent Phrase is also named as *de*Phrase by Cheng & Sybesma (1999), which can be interpreted as: ‘to the extent that.....’

analyzed as a compound, corresponding to the English gerundive reading ‘horse-riding’, which functions as an adjunct, or as a VP, corresponding to the English past-tense event reading ‘rode a horse’, which functions as a predicate. The goal of this line of inquiry is to accommodate the Chinese VCC to the generative analyses.

The other observation between the two languages is that, in Chinese, the same meaning ‘ride horse for three hours’ must be realized by copying the verb 骑 qí ‘to ride’ twice; while in English, only one verb suffices. The universal syntacticians claim this is the result of the Copy+Merge Theory of Movement, which is cross-language applicable. The constructional grammarians have a ‘source-oriented (Bybee, 1995)’ perspective, assuming this difference comes from the distinct form-meaning templates (or abstract schemas) stored in the mental lexicon. Therefore, Chinese speakers and English speakers will associate the same meaning to the particular pre-stored templates in their own lexicons.

Analyses under the generative and construction frameworks attribute this peculiar form-meaning mapping either to syntax from a universal perspective or to lexicon from a cognitive perspective. In the following part of this section, specific theoretical hypotheses regarding the VCC are elaborated. Notice that by taking a reductionist approach, at this stage, I will not attempt any evaluations on the aforementioned hypotheses; only after testing the hypotheses with valid psycholinguistic methods and measures shall I come up with conclusions either confirming or rejecting any theoretical assumptions.

1.1.1 Syntax

The verb copy construction is not a widely observed construction but neither is it unique to Chinese language. Koopman (1984: 154) reported that Vata language also has obligatory verb copies. In cleft sentence, when the verb clefts; both the higher copy and the lower copy of the verb must be pronounced as the bold words indicated in (2).

- (2) **ng̃n̄** ò ò wā nà ò ká **ngónò** á
 sleep you want NA you FUT-A sleep Q
‘Sleep, isn’t it what you want?’

The generative analysis of verb copy constructions are specialized by the Copy + Merge Theory of Movement. Nunes (1999, 2004) proposes that multiple-copy durative constructions are derived through the Copy + Merge theory of movement, the result of the merging of verb with an indefinite N(P). Both sentences (a) and (b) have multiple copies of the verb phonologically realized, forming a complex predicate within one clause. Chinese data involving V-O structures are presented by Huang (2005) and Cheng (2007) to discuss: a) verb copying theory in deriving complex predicates containing V-O compounds, and b) control theory in pro-drop environment containing V-O sequence. In both of the studies, the (L)exical (I)ntegrity (H)ypothesis (LIH, Huang; 1984, 1987) is invoked to explain the inseparability of the V-O sequence in order to maintain the Copy + Merge operations. I will represent their key arguments with regard to V-Os as in (3a&b). Reconsider the Chinese VCC sentences.

- (3) a. 他骑马骑了三个小时。
 tā qí mǎ qí le sān-gè xiǎoshí

He ride horse ride ASP three-CLASS hour

‘He rode horses for three hours.’

b. 他吃饭吃了三个小时。

tā chī fàn chī le sān-gè xiǎoshí

He eat rice eat ASP three-CLASS hour

‘He had a meal which took three hours.’

In both sentences, the same verb has two copies. The grammatical function of each of the copies is to introduce different arguments, 骑 qí ‘ride’ introducing 马 mǎ ‘horse’ and 三个小时 sāngè-xiǎoshí ‘three hours’. However, as the English glosses demonstrate, this function is realized by only one verb. Chinese obligatorily splits the work and assigns each of the arguments a verb copy; this is a strategy to avoid violation of the (P)hrase (S)tructure (C)onstraint (PSC, Huang; 1982): “*in a given Chinese sentence, the head (verb or VP) may branch to the left only once, and only on the lowest level.*” In this case, the V-O construction and the durative phrase cannot be both attached to a single verbal element. In order to realize the complex predicate containing both a direct object and the duration information, verb copying is used to create two discrete post-verbal positions. The process of verb copying is realized by the Copy + Merge operations (I will present the detailed derivations momentarily). However, the Copy + Merge operations generate multiple copies of a word in a sentence, which, in most languages, violates the ECONOMY PRINCIPLE and results in ungrammaticality. To avoid this, Kayne (1994) hypothesizes the (L)inear (C)orrespondence (A)xiom (LCA), which says: “*The linear order of terminals follows asymmetric c-commanding relationships. Therefore, the linearization of chains of copies allows only one occurrence of a word to stay if multiple occurrences of a same word are considered non-distinct copies.*” That is to say, the extra occurrence of a same

word would be deleted/ linearized from the sentence. Chinese VCC seems to be an exception to the LCA (so is the data in Vata). Huang(1984, 2005)’s explanation for keeping both of the verb copies in the sentences is the LIH, which postulates that the inner V-O of the VCC structure is actually equivalent to a compound word (X^0) after one copy merges with the object in the νP layer³. X^0 as a word level unit must participate any syntactic operations holistically; the inner component of X^0 is invisible to the syntax. As a result, the verb copy inside the V-O sequence should not be accessible by the LCA’s operation and thus survives from the deletion. In this way, two copies of the same verb are both pronounced.

Take the sentence in (3b, repeated as 4) for instance.

(4) 他吃饭吃了三个小时。

tā chī fàn chī le sān-gè xiǎoshí

He eat rice eat ASP three-CLASS hour

‘He had a meal which took three hours.’

The process is as follows: The derivations follow a series of operations in the order presented below (cf. Cheng, 2007).

- i) In order to accommodate two post-verbal NPs, one more verb position needs to be created; thus copy the verb ‘to eat’; merge it with ν in νP layer.
- ii) In order to check the argument feature of the copied verb, copy the object ‘rice’ and merge it with ν , resulting in a V-O sequence eat-rice. Because of their

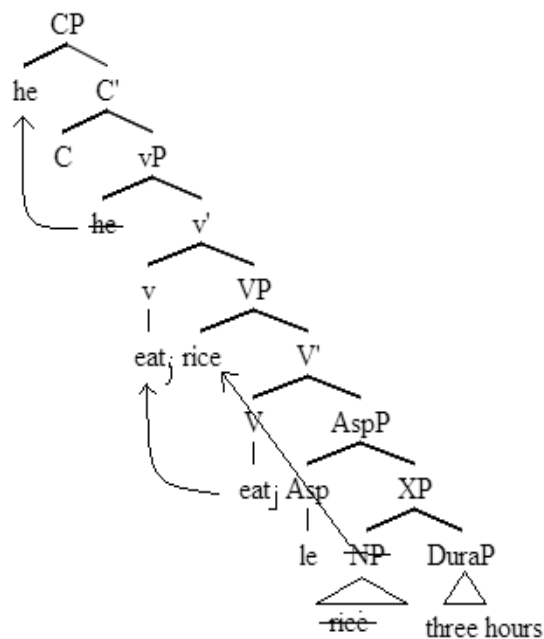
³ There are many debates since the formulation the little ν layer by Larson’s (1988) in analyzing of the ditransitive verbs. Larson concludes that there is a split VP. Chomsky (2001) argues for little ν . Kratzer (1996) calls it Voice. The idea is that the verb is split into two domains syntactically (see Marantz 2013, for a thorough review). In the Chinese VCC, the inner V-O sequence seems to follow the analysis Ramchand (2008, 2011)’s interpretation, which νP layers are postulated to “*isolate the irreducible properties of the computational system*”, compatible with the LIH analysis that the V-O is a compound like chunk.

juxtaposition in the event layer, the V-O sequence gains an activity reading and become a compound word. According to the LIH, its inner element V is only a word component and not accessible to any further syntactic operations; thus the verb copy in the V-O sequence survives.

- iii) Delete the lower copy of the object to fulfill the PSC. Then the base-generated ‘to eat’ becomes immediately adjacent to the aspectual bound morpheme *le*, forming a V-*le* unit, which is recognized as a distinct verb by LCA, thereby being kept in the structure.

The tree graph in Figure 1.1 presents the operations the sentence 他吃饭吃了三个小时 *tā-chī-fàn-chī-le-sān-gè-xiǎoshí* he-eat-rice-eat-*le*-three-CLASS-hour ‘he had a meal which took three hours’.

Figure 1.1 Syntactic operations



1.1.2 Mental lexicon

The first assumption attributing the verb-argument structures to the mental lexicon can be traced back to the lexicalist approach (LA) brought up in Chomsky's *Remarks on Nominalization* (Chomsky, 1970; cited from Marantz, 1997), which proposes that the argument structure is pre-stored with the verbs in a generative lexicon and as such, English gerundive phrases like '*his loving of his daughter*' are created pre-syntactically in a generative lexicon. Two formal distinctions between syntax and lexicon can be observed in the English data:

- a) the gerundive forms are not as predictable by the syntactic operations, a verbal phrase may have more than one nominal realization as shown above, but sometimes, not all the realizations are acceptable, as in the contrast '**his growth of the tree*' versus '*his growing of the tree*' (Siddiqi, 2009:11);
- b) although the nominal has a verb-like argument structure, it behaves like a noun, taking a nominal slot serving as a DP/NP;
- c) the gerundive forms are morphologically marked by *-ing*.

Based on these accounts, the LA may provide criterion for the identification of English gerundives by their distinct morphology and syntactic distributions, but may prove problematic for Chinese data. Consider the contrasts indicated by the slash in (5).

- (5) a. 李四爱骑马/马。
 Lǐsì ài qí mǎ/ mǎ
 Lisa love ride-horse/ horse
 'Lisa likes horse-riding / horses.'

‘Lisa likes to ride a horse / horses.’

b. 李四骑马/马骑了三个小时。

Lǐsì qí-mǎ/ mǎ qí le sān-gè xiǎoshí

Lisa ride-horse/ horse ride ASP three-CLASS hour

*‘Lisa rode a horse / *horses for three hours.’*

*‘Lisa did horse-riding / *horses for three hours.’*

The simplex noun *ma* ‘horse’ after the ‘/’ shows that the crucial slot can be occupied by a complex V-O or a simplex noun; while English cannot (see ‘*’ parts in 5b). Two ways of English translation also suggest that the V-N sequence can be interpreted as a verb phrase or a gerundive phrase. The immediate question that arises here is how native speakers would identify the V-O sequence in this ambiguous context: is it perceived as a nominal and interpreted as ‘horse-riding’ indicating activity or as a verb phrase ‘to ride a horse’ as a one-time action.

Similarly, the Construction Morphology (CM), as a usage-based approach, places complex word formation within the architecture of grammar. CM assumes a hierarchical lexicon, where both productive phrasal lexical constructions such as verb-argument constructions and complex words such V-N compounds are associated on the basis of the paradigmatic relationships in analogy with *look-ed* and *look*. In other words, there is no sharp distinction between grammar and lexicon, more fundamentally, there is no distinction between language competence or (I)nternal- language, and language performance or (E)xternalized-language. Jackenoff (1975, 2002) introduced Lexical Redundancy Rules in order to capture the native speakers’ intuitions of the lexical relatedness, stating that fully regular complex words can be stored in the mental lexicon. In language acquisition, the *full-entry* theory is invoked by the constructionists to tackle

the cases that do not follow generative rules. Langacker (1987) points that there is no logical contradiction between the existence of a productive process (generative rule) and the storage of the outputs of that process. Particular to the structure under discussion, Chinese has a productive schema for V-O structures applicable at both word level and phrase level. Yet, native speakers still store many V-O sequences in their lexicon as they are conventionalized names.

In addition, the Construction Grammar (CG) also proposes that the lexicon stores not only outputs of the process, but also some semi-productive constructions or templates, which are arbitrary to a certain extent (*semi-frozen*, Goldberg, 1995; Jackendoff, 2003) and still enjoy high productivity. Under this view, the Chinese VCC is also pre-stored as a verbal template.

Baayen et al. (2003) further point out that it is the frequency effects that allow the regulars (both word level and phrase level units) to be pre-stored; Clahsen & Neubauer (2010) argue that the inner morphological structure of a stored regular form is still accessible because of its regularity. If these points were also true for Chinese language, it can be predicted that a high-frequency V-O sequence would be processed faster than a low-frequency V-O sequence. But what would happen in the case of a low-frequency V-O derived through the pre-stored VCC template? Does the template cause a stronger prime in integrating the whole VCC, or is frequency still the main effect that would allow the V-O to be processed independently from the whole VCC?

1.1.3 Summary

The analyses under different theoretical frameworks, for both derivational lexicon and derivational syntax, provide different accounts for the V-O sequence behaving like a nominal compound. Jackendoff (2011) puts forward a ‘graceful integration’ criterion to assess linguistic models, which suggests that a grammar model should be in harmony with the findings in extra-linguistic domains such as language acquisition, processing, language change, etc. (cited from Booij, 2014). In the rest of this chapter, a reductionist view is adopted to test the theoretical assumption for Chinese V-Os in language processing. Evidence from two experiments is presented to examine the status of the V-O in native speakers’ cognition. In Experiment I, NSs’ responses to the V_H blank and the V_L blank were elicited. Then discussion on the derivation of the V-O sequence in syntax is revisited based on the experimental findings. In Experiment II, the response time of the O- V_L sequences was examined in a self-paced reading task. The processing of the VCC and its status in the lexicon is discussed following the presentation of results. In the end, a general conclusion interfacing syntax and lexicon is advanced.

1.2 Experiment I

As the theoretical analyses postulated, the interpretation of the VCC may involve two parsing processes: long-distance linking --- to establish a verb-copy dependency --- and speech segmentation, to isolate the V-O sequence. The purpose of the current experiment is to elicit information that could tell us whether a NS is linking discrete elements, namely the two verbs in the $V+O+V+(D)urative (P)hrase$ construction, or separating sequential elements, namely the V-O sequence from the V-DP sequence.

Therefore, the existing linking needs to be broken down in order to observe if/how a NS would rebuild it. Lexical elicitation experiments show that people can make use of surrounding lexical and syntactic information to complete a sentence with a very specific verb. For example, Gillette et al. (1999) found that adult native speakers are able to predict the missing verb 75% of the time based on the present words in the fragmental sentence and sentence structures. Becker (2005) showed that two particular types of lexical cues combined with two particular types of structural blanks elicited raising verbs and control verbs respectively. Thus, in this experiment a fill-in-the-blank (FITB) design was adopted, using incomplete VCCs as the structural prime with one of the verb copies missing. The hypotheses are: if the blank is completed by the missing verb copy, the linking between the two verbs will be successfully rebuilt; otherwise, the two verbs are not recognized as being associated, suggesting the V-O sequence may be interpreted separately from the V-DP sequence.

Measures and procedures

The FITB design has 1 factor (sentence format: Subject + V_H + Object + V_L + *le* + Durative Phrase) with 2 levels (V_H missing; V_L missing). The test contained two sets of 20 sentences constructed from 10 base VCC sentences. An example of three different types is given in Table 1.1 (see Appendix A.1 for all-item list).

Table 1.1 Test item example

Base sentence	Verb-copy	Ta qi _{VH} ma qi _{VL} le san-ge xiao-shi He ride horse ride ASP three-CLASS hour 'He rode a horse for three hours.'				
Condition 1	V _H -empty	Ta ____ ma	qi	le	san-ge	xiao-shi
Condition 2	V _L -empty	Ta qi ma	____	le	san-ge	xiao-shi

All twenty sentences were distributed in two counterbalanced lists, each containing five Condition 1 sentences and five Condition 2 sentences. Two conditions of the same base sentence never appeared in the same list, in order to avoid priming effects between the test items. Although the two conditions were constructed based on the verb-copy sentence, the empty slots did not necessarily need to be filled with a verb copy to form a grammatical sentence. The filler items were noncopy words of different lexical categories. Participants were only told to complete the sentence with the word (never phrase) that they think best fit the context in 200 seconds, each sentence taking 20 seconds on average.

Participants

The participants were 47 graduate students (26 females; 21 males; 1 Taiwanese's data was excluded) enrolled in a PhD program at the Beijing Language and Culture University. The mean age of the participants was 37.5 years, and the mean self-reported time of living in China was 37.5 years. To elicit the intuitive responses, the participants were asked to complete a 10 sentences FITB questionnaire in paper-pencil format within 200 seconds, 20 seconds for each sentence on average. 47 participants were randomly divided in two halves; one half (24) was assigned to complete test List A, the other half (23), test List B. Before the main experiment, participants were briefly introduced to the format of the task and given a training questionnaire, including five sentences with other complex predicate constructions (e.g. *ba*-construction; *bei*-construction, etc.).

Results

First, the elicited responses were distinguished as a copy or a noncopy: the V_L blank responses were categorized according to whether it was a copy verb or a noncopy verb;

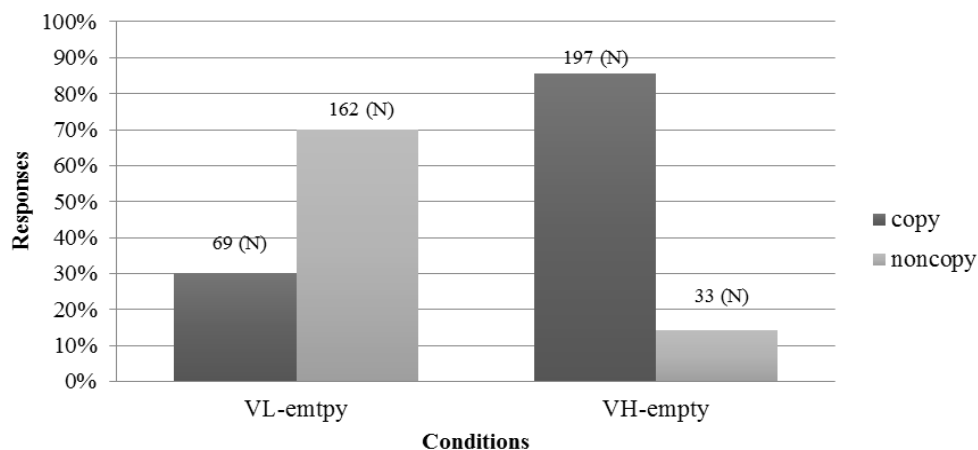
the V_H blank responses were categorized according to whether the response was a copy verb or a non-copy word, which was not necessarily a verb. The results are presented in Table 2. In current and subsequent tables, the left column indicates the count and the right column indicates the percentage, in Table 1.2, the percentage of responses to a sentence condition that were V_L -empty condition and V_H -empty condition; the right column indicates the counts in Table 1.2, the number of such responses.

Table 1.2 Responses in two conditions

Condition type	Response type			
	Copy (%)		Non-copy (%)	
V_L -empty	69	(30)	161	(70)
V_H -empty	197	(85.65)	33	(14.35)

Chi-square test results showed that there was a significant main effect between condition types and the copy responses: a copy response was offered significantly more often given a V_H -empty condition than a V_L -empty condition, Chi-square = 23.68, $p=0.0048$, mean- $V_H=10.035$, mean- $V_L=3.83$; a noncopy response was offered significantly more often given a V_L -empty condition than a V_H -empty condition, Chi-square=26.67, $p=0.0016$, mean- $V_H=3.035$, mean- $V_L=8.23$. Figure 1.2 presents the differences between two conditions and within each condition (N indicates counts).

Figure 1.2 Copy vs. noncopy response distributions



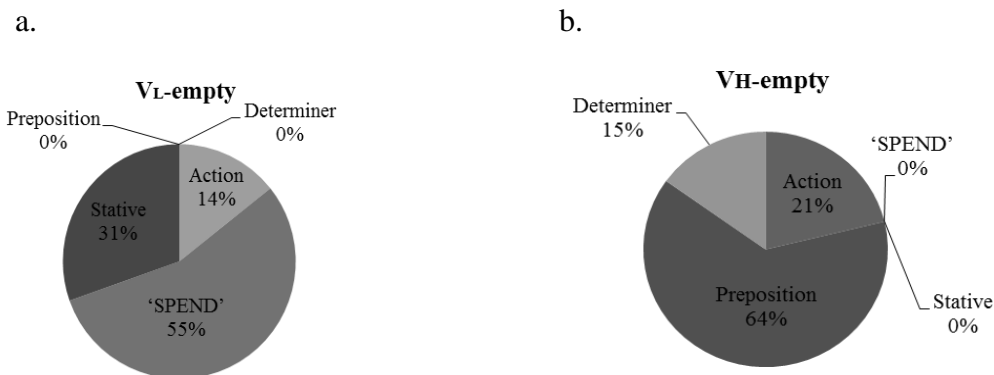
In the second step of classification, the noncopy responses were further categorized into sub-groups. Given that V_L blank constrained the responses to be verbal because an aspectual marker *le* immediately followed the blank, all the noncopy responses of Condition 1 were verbs. Since the V_H blank was the categorically less constrained position, the noncopy responses of Condition 2 included different lexical categories of words. Table 1.3 presents the noncopy categorizations and percentage among both types of responses (copy and noncopy).

Table 1.3 Noncopy responses in two conditions

Response type		Condition type			
		V _L -empty		V _H -empty	
Verb	Action	10%	23(N)	3.04%	7(N)
	‘SPEND’	38.75	89(N)	/	/
	Stative	21.35	49(N)	/	/
Non-verb	Preposition	/	/	9.13%	21(N)
	Determiner	/	/	2.17%	5(N)
Total		70%	161(N)	14.34%	33(N)

Within each condition, there was one type of noncopy responses showing a higher ratio than any other types of noncopy responses. They were respectively the ‘SPEND’ verb in Condition 1 and prepositions in Condition 2. In Figure 1.3, two pie figures present the ratio of each type of noncopy responses within two conditions.

Figure 1.3 Ratios of each type of noncopy responses within two conditions





Since Condition 1 (V_L -empty) only elicited verb responses, the sub-categories of the noncopy responses were all verbs. A particular semantic group of verbs, named ‘SPEND’, were observed, taking up one third of the total responses. This group included various lexical items associated with the meaning of SPEND, such as 花 *huā* ‘to spend’, 用 *yòng* ‘to use’ and 费 *fèi* ‘to waste’. As the name indicates, SPEND verbs predicate on durative phrases, expressing ‘how much time was spent by doing the activity’. In addition, intransitive verbs were also observed only in Condition 1, including different stative verbs such as 累 *lèi* ‘to be tired’ and 困 *kùn* ‘to be sleepy’. This type of verbs predicates on the subject 他 *tā* ‘he’, expressing ‘what was the state of him after doing the activity’. The action verbs elicited in Condition 1 were transitive verbs. Unlike verb copies or SPEND verbs, this type doesn’t predicate on any NPs present in the context, but on the event-related objects that were absent, expressing ‘what sub-activity was done while the main event was happening’. In Figure 1.3b, the ratio of each type of noncopy responses within this condition was presented.

In Condition 2 (V_H -empty), the blank was followed by a NP, which allowed the blank to be filled by three categories of words. When filled with a preposition, such as 在 *zài* ‘at; in’ or 为 *wéi* ‘for’, forming an adverbial PP with the following NP, introducing the location of the V_L ’ action, as in 在那个房间打扫了一天 *zài-nà-ǎng-fáng-jīān-dǎ-sǎo-le-yī-tiān* in-that-house-clean-*le*-a-day ‘did the cleaning in that house for a day’, or introducing the purpose of the V_L ’s action, as in 为英语考试准备了一天 *wéi-yīngyǔ-kǎoshì-zhǔnbèi-le-yītiān* for-English-exam-prepare-*le*-a-day ‘did the preparing for the English exam for a

day’, or the means/manners of the V_L ’s action, as in 骑自己心爱的车子 qí zìjǐ-xīnài-de-chēzi-zhǎo-le-yītiān ride-self-beloved-bike-look for-*le*-a day ‘look for (something) by riding his beloved bike’. When the blank was filled by a verb, the V_H -NP- V_L sequence formed a serial verb construction (Li & Thompson, 1981), with the V_H -NP combination introducing the manner of the V_L ’s action, as in 打开电脑玩了一天 dǎkāi-diànnǎo-wán-le-yītiān open-computer-play-*le*-a day ‘having the computer opened, (he) played (on it) for a day.’ When the blank was filled by a determiner or a null, such as 一场 yī-chǎng one-CLASSIFIER, a Determiner Phrase was formed, serving as the object of the V_L ; only the object was fronted to the pre-verbal position and the O- V_L constructed a topic-comment sentence, which is used to emphasize some property of the event, as in 一场考试考了半天 yī-chǎng-kǎoshì-kǎo-le-bàntiān one-CLASS-exam-take-*le*-half day ‘one exam, (he) took a half day’.

Discussion

The results demonstrated an asymmetric distribution of copy responses. For the same base sentence such as (6a), in Condition 1 where the V_H -O sequence was pre-formed and offered, NSs tended to not refer to the inner element V_H of the V_H -O sequence to fill the V_L blank, as illustrated in (6b). In this case, the dependency between V_H position and V_L position failed to be identified, so the VCC was not rebuilt; in Condition 2 where the verb in the V_H -O was not offered, NSs more often back-referred the V_L to fill the V_H blank. Only in this circumstance was the VCC rebuilt, as illustrated in (6c).

- (6) a. Ta chi-_{VH} fan-NP chi-_{VL} le yi ge xiaowu *base sentence*
 He eat rice eat le one CLASS afternoon
 'He (eating meal) ate for the whole afternoon.'
- b. Ta chi fan hua le yi ge xiaowu
 he [eat-V] rice-NP [spend-V] le the whole afternoon *not referred*

- c. Ta chi fan chi le yi ge xiaowu
 he [eat-V] rice-NP [eat-V] le the whole afternoon *back-referred*


In conclusion, when the V-O sequence is formed and presented in a complex predicate, it is sufficient to provide an interpretable meaning, and then it is more likely to be interpreted holistically as the English gerundive phrases are (see the English gloss in the parentheses in (3a)). This result confirms the syntactic postulation that the *vP* layer endows the V-O sequence with a compound property, relatively independent in function and semantics. Functionally, it serves as V^0 , whose inner elements do not interact with the main clause on individual base (as LIH proposes); semantically, it is introducing the event frame, with no need to carry any aspectual information (as DM proposed). In contrast, when the V-O sequence is yet formed, the linear fragment is semantically insufficient. Under such circumstances, the V_L presented immediately after the object is the most readily available reference in order to comprehend the sentence, thus often being back-referred as the governor of the object. Since Chinese is a verb-first language, the verb-argument structure is typically realized in the format of V-O, rather than O-V, the V_L is copied. Even for the noncopy responses, the formation of the serial verb construction and the topic-comment construction both depend on the back-referring of the V_L . The back-referring behavior supports the syntactic derivation in which the lower verb is base-generated; the higher one is the copy, internally merging with the object to

fulfill the PSC. Though the back-referring did not directly justify the NSs' identification of the V-O sequences, the results that the V_H blank can be filled by prepositions and determinations (forming nominal phrases) may also suggest that the V-O sequences occurring in this position share some properties with those nominals. In other words, it is very likely that the V-O sequences are holistically being treated as nominal, parallel with English gerundive phrases, even though internally it is a verb-argument structure.

In conclusion, NSs responses in Experiment I showed that the V_H -empty frame was a structurally better prime to elicit verb copies and form VCCs. The results provide empirical evidence for the Copy + Merge derivations of the VCCs from the language processing perspective. The insufficiency of the V_L -empty frame as a VCC prime is a proof of the hypotheses that the V-O sequence is an independent integrity, causing the parsers to disassociate it from other verbal constitutions in the same sentence.

1.3 Experiment II

Design

In Experiment I, we simulated the generation route of the VCCs by manipulating the structural primes in order to investigate NSs' identification of the dependency between the two verbs. In Experiment II, a self-paced reading task was utilized to explore other potential factors that may affect the processing of the VCC proposed by the generative and the constructionist approaches. In order to achieve that, multiple linear regression models are used. Yan & Su (2009: 41) elaborated the function of this model in the book *Linear Regression Analysis*: “The general purpose of multiple linear regression is to seek for the linear relationship between a dependent variable and several independent

variables. Multiple regression allows researchers to examine the effect of more than one independent variables on response at the same time.” Particular to this experiment, multiple factors are postulated by the theoretical hypotheses to predict the formation of the VCC. Therefore, in order to confirm which factors are more likely the real predictors to the processing of the VCC, multiple regression analyses were invoked to reveal whether or not there is a significant correlation between the processing speed and each of the potential factors.

Research questions and independent variables

In this part, the research questions and the hypotheses will be outlined, followed by the independent variables (parameters) serving as the indicators of these hypotheses.

(1) Research question I (RQI): Is VCC a pre-formed template in NSs’ brains?

Hypothesis #1: The VCC is a pre-formed template, so the two verb copies in it are also pre-linked. Thus, NSs should recognize the lower verb faster when it is a copy of the higher verb, and more slowly when it is not a copy of the higher verb.

Hypothesis #2: The VCC is not a pre-formed template, but an online derived structure in order to fulfill the PSC (forbidding two post-verbal arguments), so the two verb copies’ association is online built through general syntactic operations. Thus, whether or not the lower verb is a copy of the higher verb will not affect the NSs’ response times to the lower verb.

To examine the RQ I, we deliberately disassociated the two verbs by offering the higher verb as a prime, and targeting the lower verb. For that matter, the V-O-V sequence was separated into two chunks—[V] and [O-V]. The design was controlling the higher

verb and the Object, and comparing the lower verb in two different conditions—being a copy (V) and being a non-copy (V'). Therefore, the first independent variable predicting the RT is the **structure conditions** as copy or noncopy.

Another well-studied factor that may influence the processing speed is **n-gram**, a contiguous sequence of *n* items, or in other words, the linear size of a sequence (Broder, 1997; Elis, 2008; Sidorov, 2013). For instance, a five-gram V-O sequence such as 打游戏 dǎ-diànnǎo yóuxì hit-computer game 'to play computer games' may take longer processing time than a three-gram V-O sequence such as 打游戏 dǎ-diànnǎo hit-computer 'to play computer (games)'. Thus, the length of a V-O-V sequence should also be included as a potential predictor to the processing speed. In Chinese, which is a monosyllabic language, n-gram can be represented by syllable numbers. Therefore, the **syllable structure** was taken as the indicator of the O-V(')'s length given that O-V(') was the target chunk as previous design showed.

Besides, the discussion on the methodologies of the visual-lexical decision tasks (Samson, 2004) showed that orthographic complexity overrides the concreteness effect in word recognition. For Chinese, the orthographic complexity can be represented by character **stroke numbers**. For instance, the character for the verb 'to climb' 登 has 12 strokes and the character for the verb 'to travel' 游 has 12 strokes, so the orthographic complexity of the two characters may be considered the same. In the present experiment, the only different verb in a pair of stimuli O-V *le* and O-V' *le* was the lower verb. However, because it was sometimes difficult to find a noncopy lower verb V' that is a synonym of its counterpart V having similar stroke number, we balanced the stroke

numbers across the two sets, ensuring that the average stroke numbers of the V set and V' set were matched for the paired sample t test. Since the stroke number was roughly controlled, there was still difference in visual complexity from item to item and we also wanted to consider each trial as an independent observation, stroke number must also be an independent variable.

(2) Research Question II (RQII): Whether or not a high-frequency inner V-O of a V-O-V could be a pre-listed item and thus will be independently retrieved faster even being embedded in a VCC?

Hypothesis #1: The V-O combination can be a pre-listed item if it is a high-frequency collocation; NSs would respond to a V-O faster no matter it is embedded in a VCC or a non-VCC.

Hypothesis #2: The V-O combination would not be retrieved as an independently listed item when embedded in a VCC because the structural linking of the V-O-V is pre-existing and being stronger a prime; thus the NSs' response speed would not be affected by the frequency of the V-O collocation given a VCC context.

In the literature, word frequency is a well-documented factor in predicting the RT (Elis, 2008; Nan, 2004, 2007; Zheng & Li, 2015). However, in our case where the wordhood of the inner V-O sequence is unclear, the correlation between the V-O's frequency and its RT should be re-tested. The ideal instrument to test the status of the V-O and its correlation to the frequency is to track the eye movement and see if the gaze will fall in between the V-O-V or fall after the whole V-O-V. Given the limited resource and time, we chose to pursue this aim in the same self-paced reading task, which I will show is the feasible and valid a method.

Recall that in the previous design, the O-V sequence has two conditions with O-V being as in the VCC sentence and O-V' being as in the non-VCC sentence. The O-V(') sequence is formally the **reversed order** sequence of the V(')-O collocation. If we can show that the RT of a reversed order O-V sequence is also significantly associated with the frequency of its canonical order V-O sequence, then the only thing we need to do is to further manipulate the frequencies of the O-V(') chunks on the basis of previous design. Ding & Peng (2006) and Bai et al. (2011) used reaction times and ERP records, respectively, to compare the processing of the Chinese reversible compounds (i.e. 蜂蜜 fēng-mì 'bee's honey' & 蜜蜂 m ìfēng 'honey bee') and non-reversible compounds (i.e. 功课 gōng-k èffort-class 'homework' & *课功 k ègōng class-effort, a nonsense word). The results showed that the possible combination of the two characters was activated in both reversible and non-reversible conditions; but only in the reversible condition was the interfering effect aroused. Based on the interactive activation model (McClelland & Rumelhart, 1981; Taft, 1991), the two characters (蜂 fēng 'bee' & 蜜 mì 'honey') would elicit parallel activation of the two candidates—the base form (蜂蜜 fēng-mì 'bee's honey') and the reversed form (蜜蜂 m ìfēng 'honey bee')—and thus a sublexical selection procedure is required to discriminate the two candidates. The findings supported the lexical retrieval model and suggested that the activation of the two characters' combinations is very strong a prime “*no matter what order of the two characters in the compound is* (Bai et al.; 2011)”. Particularly in current experiment design, even though it was the reversed order of the V-O sequences (as an O-V sequence) being presented, its canonical order would be activated as well. As for the role of the frequency playing here,

Caldwell-Harris and Morris (2008) reported a temporal illusion phenomenon observed in perceptual identification on familiar collocations. When the word combinations were highly frequent, but presented in reversed order such as ‘code zip’, the participants reported that they perceived the canonical order ‘zip code’. This finding suggested that the perceivers would spontaneously reverse word pairs into the default order, and the more frequent the collocation is, the faster this reversal processing would be. According to previous findings, we believe that the RT of the reversed order O-V collocation can be used as an indicator to the status of the canonical order V-O collocation in the mental lexicon. Therefore, frequency of the V-O collocation needs to be controlled.

In this study, **Mutual Information (MI) score** was used as an indicator of the collocation frequency. MI score is often used to indicate the possibility of two words co-occurring in certain corpora (Biber et al., 1998: 265; Gerard, 2007: 164; Elis, 2009). The formula is: $MI = \log((f_{AB} * SIZE) / (f_A * f_B)) / \log(2)$. $F(A)$ stands for the frequency of word A; $f(B)$ stands for the frequency of word B; $f(AB)$ stands for the frequency of AB’s co-occurrence; $SIZE$ stands for the size of the corpus—how many words are included. In Chinese, the size of a corpus is calculated by character not by word. Given that 83% of Chinese words are two character words (Zhou, 1999), we derived the $SIZE$ by dividing the official reported size of the selected corpus by 2. In this study, BLCU Chinese Corpus (BCC) was used, including 150 billion characters; thus 75 billion as the $SIZE$. Therefore, MI score was also taken in as an independent variable to predict the RT and was manipulated. The MI score was manipulated in favor of the non-VCC condition in such a way that we selected non-copy V’s to ensure the frequency of each V’-O collocation must be higher than that of its V-O counterpart. For example, the O-V 马练 mǎ-li àn

horse-practice was embedded in the VCC 练马练 li àn-mǎ-li àn practice-horse-practice; its reversed order V-O 练马 li àn-mǎ practice-horse has a lower MI score (MI=1.09). In contrast, its counterpart V'-O 骑马 q ímǎ ride-horse, whose reversed sequence was embedded in the non-VCC as 练马骑 li àn-mǎ-q ípractice-horse-ride has a higher MI score (MI=3.3). Notice that the high-low MI score contrast does not necessarily exist between each pair of the stimuli but was significant between the list of the O-V' chunks (non-VCC condition) and list of the O-V chunks (VCC condition) ($df=38$, $t=9.06$, $p<.0046$).

Thus far in hypotheses, four independent variables, namely, structure condition, syllable numbers, stroke numbers and MI score are set as the potential influential factors to the O-V chunks. It bears repetition that none of these variables has been confirmed as a predictor to RT in the VCC context. More importantly, the structure condition and the MI score (the collocation frequency) are merely indicators of two different theoretical assumptions. Therefore, the relations between the dependent variable and the independent variables is uncertain and needs to be tested. For that purpose, this study used: 1) a paired sample t-test for RTs of O-V chunks and their counterpart O-V' chunks; and 2) a multiple regression model with sentence structure, MI score, stroke number and syllable structure used to predict RT.

Materials

The test materials consisted of 20 VCC sentences, 20 non-VCC sentences and 20 filler sentences. The 20 VCC sentences contained 20 V-O combinations of different

syllable structures. The syllable structure of a V-O combination is represented by the syllable number of the Verb plus the syllable number of the Object; as such, 1+2 stands for a one-syllable Verb collocating with a two-syllable Object. The test materials included 1+1 disyllabic structures, 1+2 tri-syllabic structures, 2+2 four-syllabic structures, 1+3 four-syllabic structures and 1+4 four-syllabic structures. A set of non-VCC sentences was then constructed by replacing the lower verb copy in a VCC sentence with a noncopy verb (V') with similar stroke number. The replaced noncopy V' predicates on the Object as the higher verb does. In addition, the V'-O collocation must have a higher MI score than its counterpart the V-O collocation. Table 1.4 gives an example of the VCC and non-VCC contrast (see Appendix A.2 for the actual test items).

Table 1.4 VCC vs. non-VCC test measure examples

	Non-VCC	VCC
	S V O V <i>le</i> DP	S V O V' <i>le</i> DP
	他练马骑了一天	他练马练了一天
	tā li àn mǎ qí le yī tiān	tā li àn mǎ li àn le yī tiān
	he practice horse ride <i>le</i> a day	he practice horse practice <i>le</i> a day
	'He practiced riding a horse for a day.'	'He practiced riding a horse for a day.'
V-O	骑 马	练 马
	qí mǎ	li àn mǎ
	ride horse	practice horse
MI	3.3	1.09

The 40 test sentences were distributed into two counterbalanced test lists A&B, with each containing 20 VCC sentences and 20 non-VCC sentences. Both of the lists also contained the same 20 filler sentences. Two conditions of the same base sentence never appeared in the same list. Participants would be randomly assigned with either List A or List B and encounter the same context in either VCC structure or non-VCC structure but never both.

Participant and procedure

In this experiment, 12 Chinese students (4 male; 8 female) were recruited from an American university. The participants took the test individually, randomly assigned with either List A or List B. They were given instructions including 5 practice items prior to the 40-item full test with all sentences appearing one by one in a random order on the computer screen. The task was to read the sentences as fast as they can and then answer a Yes/No question after each sentence. The participants unfolded the sentence by pressing Space key and responded by pressing left/right arrow key. The presentation of the test materials was programed by Paradigm 2.4⁴. The procedure lasted 10 minutes for each participant.

In a self-paced reading task, sentences are presented chunk-by-chunk following linear reading order as presented using the following segmentation:

Non-VCC stimuli **Subject / V / O-V le / durative P.**

Critical part → --他 ‘he’
 -----练 ‘practice’
 -----马骑了 ‘horse-ride-le’
 -----一天 ‘a day’

VCC stimuli **Subject / V / O-V’ le / durative P.**

Critical part → --他 ‘he’
 -----练 ‘practice’
 -----马练了 ‘horse-practice-le’
 -----一天 ‘a day’

⁴ The software can be found in <http://www.paradigmexperiments.com/>; publications using this software are listed in the column ‘Who is using it?’

As participants respond to each chunk by pressing the response key, the response latency of each chunk is recorded.

Results and Discussion

All incorrect responses were excluded from the data. Responses shorter than the low cut off set at 200 milliseconds (ms), or longer than the high cut off set at 2000ms were also excluded. Table 1.5 presents the mean data.

Table 1.5 Examples of the test results

	Stimuli	Dependent	Independent Variable			
		RT	Condition	MI	Stroke	Syllable
1	马骑	624.93	Non-VCC (0)	3.3	14	2
	‘horse-ride’					
	马练	562.71	VCC (1)	1.09	11	2
2	‘horse-practice’					
	衣服换	480.34	Non-VCC (0)	3.3	24	3
	‘cloth-change’					
3	衣服试	478.03	VCC (1)	1.43	22	3
	‘cloth-try’					
	考试准备	479.89	Non-VCC (0)	2.53	32	4
4	‘exam-prepare’					
	考试复习	332.26	VCC (1)	3.15	26	4
	‘exam-review’					
	电脑游戏玩	492.04	Non-VCC (0)	3.87	41	5
	‘computer game play’					
	电脑游戏打	483.5	VCC (1)	2.39	38	5
	‘computer game hit’					

First, a paired sample t-test was run across two lists of target chunks. The results showed no significant difference between the processing speed of high-frequency O-V’s and of low-frequency O-Vs, $df=20$, $t=1.106$, $p=.305$.

Then a multiple regression was run across all 40 items to predict RT from MI score, sentence condition, stroke number and syllable structure. However, the four variables did not statistically significantly predicted RT, $R=.401$, $R^2=.161$, $F(4, 35) = 1.676$, $p=.178$, despite that the MI score showed a marginal effect, $Beta=.397$, $t=2.138$, $p=.04$. The results seemed to imply that neither the dependency between the two verb copies in VCC nor the frequent collocations in non-VCC served as structural primes to the processing. However, it was not the whole truth.

Another multiple regression, using the same independent variables (except the syllable structure) was run across the 23 items that only contained 1+2 tri-syllabic V-O(')s (as data 2 in Table 1.5). The results showed that the three variables were statistically significant to the prediction RT, $R=.811$, $R^2=.657$, $F(4, 19)=9.115$, $p<.000$, where only stroke number did not add significance to the prediction, $p=.352$. Table 1.6 presents the coefficients in details.

Table 1.6 Coefficients of 2&3 syllable O-V(')s

Model	Unstandardized Co.		Standardized Co.		Sig.
	B	Std. Error	Beta	t	
(Constant)	780.725	116.940		6.676	.000
Condition	-73.121	23.749	-.497	-3.079	.006
Syllable	-147.117	35.806	-.553	-4.109	.001
MI	47.579	11.895	.644	4.000	.001
Stroke	4.147	4.342	.131	.955	.352

The results of the two multi-regressions seemed to suggest that the dependency between the two verbs only exists with certain word span and the collocation effect also limits to a certain length of sequence. To verify this observation, the same multiple regression was run across the rest 16 items that contained only four and five syllable O-V(')s (as data 3&4 in Table 1.5). The results showed that the variables did not add

statistically significantly to the prediction, $R=.691$, $R^2=.477$, $F(4, 11)=2.508$, $p=.106$;

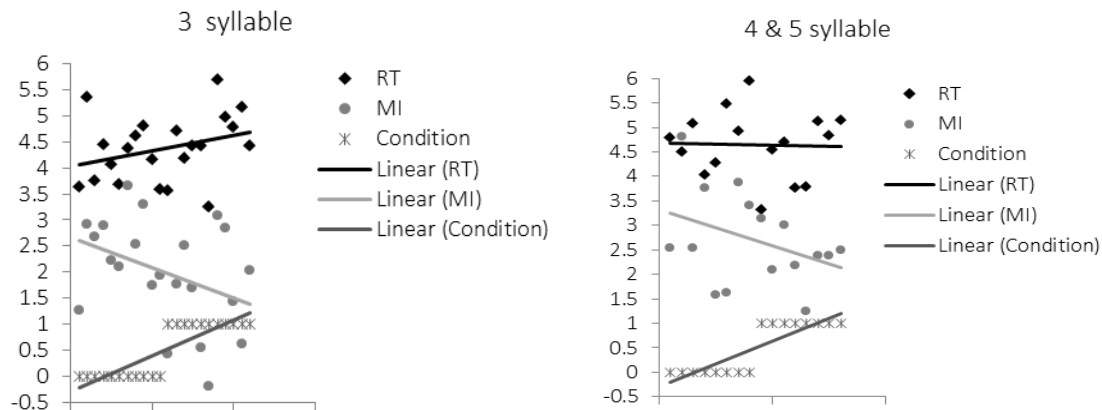
Table 1.7 presents the contribution of each variable to the RT.

Table 1.7 Coefficients of 4&5 syllable O-V(')s

Model	Unstandardized Co.		Standardized Co.		Sig.
	B	Std. Error	Beta	t	
(Constant)	305.305	216.445		1.411	.186
Condition	57.781	30.964	.437	1.866	.089
Syllable	47.055	47.202	.308	.997	.340
MI	-8.011	18.852	-.110	-.425	.679
Stroke	-3.531	3.158	-.341	-1.118	.287

The results of four and five syllable targets confirmed the observation that both the structure condition (VCC or nonVCC) and the V-O collocation frequency are restricted by the length of the target sequence. Figure 1.4 demonstrates the effect of the two variables that primarily underlie the basic theoretical assumptions.

Figure 1.4 Distributions and correlations of RT (second) and MI score



The regression lines showed that only in three-syllable condition did the RT was negatively/positively covariate with the MI score and the sentence condition, with the black line (RT) skewing towards the opposite/same direction of the gray lines (MI & sentence type). However, such covariate did not exist in the four-or-five syllabic

condition with the black line being almost straight.

Discussion

The multiple regression tests revealed that the two potential primes—the dependency between two verb copies and the correlation frequency—are conditioned. If the verb-copy construction is realized by a relatively short V-O-V, then the higher copy V is more likely to be a structural prime to the following O-V sequence, otherwise, the higher copy would not facilitate the processing speed of the O-V even with the V being repeated. Besides, if an O-V sequence contains too many syllables, its canonical order V-O would be hard to activate no matter how frequent the V-O is.

Moreover, from the regression results, we postulate that the insignificant t-test score may be due to the two confounded factors. Consider data in Table 1.6, where the sentence structure and frequency both significantly contributed to the RT. Given that the VCC condition and the high frequency condition were assigned to mutually exclusive items, which means on test item cannot be both a VCC sentence and enjoy a high V-O frequency; it was very likely the two main effects were balanced out by one another, resulting in an insignificant p value. However, to confirm this speculation, a finer control of either the VCC condition or the frequency is a must.

The results of the Experiment II supported constructionist assumptions that the VCC is a pre-stored template. When part of the construction is presented, native speakers could predict the following parts of it; and high frequency regular V-Os could also be pre-listed in the mental lexicon because their reverse-ordered forms can be activated faster than the low frequency ones. However, not all instances of the VCC template or high frequency V-

Os should be assumed to be members of the mental inventory. The linking of the two verb copies was only found in the sequences that contained no more than three syllables. This may lead to the claim that only short items whose lengths are similar to words or formulaic chunks are included. Longer regular forms are less possible to be pre-stored, or more likely to undergo decomposition in the online processing.

1.4 General conclusion

This study utilizes an experimental approach to investigate the formation and the status of the VCC and its inner V-O sequence. The findings support both the generative and the constructionist claims, serving as an interface between the syntax and the mental lexicon hypotheses, explained as follows.

First of all, there is evidence that the internal V-O sequences are independent chunks, interchangeable with adjunct PPs or sentence topics, providing background information to the main verb. This finding comports with the theoretical postulation of Huang (1984) that the V-O sequences have compound properties. As the LIH proposes, ‘once a word, always a word’, so the inner verb of the V-O sequences cannot play an active role in interpreting the other verb of a VCC. On one hand, the fact that Chinese does not have inflection to contrast a verb phrase and a gerundive nominal should not deter treating a V-O sequence as a multi-word lexical compound. On the other hand, the compoundhood of the V-O sequence should also not rule out the possibility that it is formed through a generative process, given that native speakers routinely copy the lower verb to fill the verb slot in V-O sequences.

Moreover, the generative process of a VCC’s production also does not rule out the

possibility that the VCC is pre-fabricated and pre-stored rather than formed on-line given the findings that a VCC sentence is processed faster than a non-VCC sentence of the same complexity, same meaning and using higher-frequency lexemes. In other words, any individual instance of the VCC may be produced through the pre-stored template; that is why they are processed faster. But the formation of the VCC template per se follows generative principles such as the Copy Merge Theory of Movement. In a word, the syntax and mental lexicon are functioning cooperatively in shaping the Internal language (the template) and producing the Externalized language (individual instance).

Chapter 3 also uses an experimental approach to examine another indeterminate multi-word problem, namely, the headedness structures of Chinese compound words.

Chapter II Headedness structures in Chinese compounding morphology: evidence from L1's productions

Headedness is widely posited to exist in all compositional structures. Haspelmath (1992, cited in Packard, 2000) posits that the historical origins of headedness derive from the lexicalization of the headed syntactic structures. However, it is also observed that compound heads are different from syntactic heads, in that the head position of a multi-word construction in a language is not always parallel with the syntactic center of the construction. Particular to the Chinese language, in which, isolating monosyllabic words (root morphemes; Sproat & Shih, 1996) can compound together to form a new multi-morpheme word, the head in morphology is more frequently intertwined with the phrasal head in syntax. Different generalizations have been proposed for the headedness structures of Chinese compounding morphology. Huang (1998) concluded that Chinese is headless in morphology. Packard (2000) proposed the Headedness Principle for Chinese, which argues that ‘all verbs have a verb on the left; and all nouns have a noun on the right.’ Ceccagno and Scalise (2006)’s study, on the contrary, argued for the prevalence in Chinese of right-headed compound words. Ceccagno and Basciano (2009) argued for three head positions, right-headed, left-headed and non-headed. In this study, one type of multi-morpheme words--compound words—were elicited and examined from Chinese L1 speakers by two elicited production tasks. The aim was to investigate whether there is a dominant headedness structure in Chinese compounding morphology based on native speakers’ productions, and to test the headedness hypotheses generalized on the basis of the textual data such as text corpora and dictionaries.

The chapter is organized as follows. In Section 1, I presented different definitions for ‘head’ in compounding morphology based on different language data in the literature; the focus is on previous attempts to describe Chinese compound head positions using textual data. In Section 2, I propose a psycholinguistic method of determining the head positions of Chinese. Two experiments using Chinese data are presented and discussed. The final part of this chapter provides a brief summary of where the headedness issue should be grounded and how it is to be tackled.

2.1 The indeterminacy of ‘head’

2.1.1 Different definitions

Unless a unit cannot be further divided, it must have an internal architecture, in which some constituents may be considered more important or representative of the whole structure. These constituents are called ‘heads’. Head constituents can signify a semantic center or a syntactic center (or both simultaneously). Williams (1981) defines the head as the constituent that determines the syntactic category of a whole construction. Cognitive perspective holders (e.g. Haspelmath, 2002) define head as a semantic determinant. A mixed approach of syntax and semantics is also proposed by Aronoff and Fudeman (2005) and Booij (2009b) due to the fact that the syntactic and semantic head usually coincide. Packard (2000: 194) concludes: “When it comes to words, scholars are quite equivocal, sometimes speaking of heads in structural terms, sometimes in semantic terms.” More often, the head of a word serves as the determiner of the whole word’s syntactic properties. For instance, a word can be decomposed into an affix plus a stem. Although the stem bears the semantics of the word, it is not necessarily the head of the

whole word. As in the English word ‘dancer’: the stem is *dance*, but the head is the suffix *-er* because it projects its nominal syntactic features to the whole word. Therefore, only in a transparent structure, in whose structure the property of the whole word and the property of each component are both accessible, can the head of the structure be determined. In compounding typology, the positions of compound heads may vary from one language to another. The Dutch compound head is consistently on the left-hand side. Scalise (1983) and Varela (1990) argue that Romance languages have a left-headed tendency in compounding. Williams (1981) and Selkirk (1982) argue that the head is always on the right-hand side in all languages. Many attempts at determining head structure follow the X-bar approach in syntax (Selkirk 1982, Sadock 1991, Di Sciullo 2005; cited from Packard, 2000: 135-59), which analyzes words in the same way as phrases. It has been argued that Chinese constructs its compounds by following syntactic rules; this argumentation leads to the conclusion that Chinese compound heads should generally follow its verb-first word order. However, Chinese cases are not as simple and definite as has been previously posited.

2.1.2 Chinese compound heads

Chinese compounds can generally be accommodated in the three-way classification of coordinate, subordinate and attributive (Bisetto & Scalise, 2005). Within each type, there are prototypical members that strictly follow the definition (i.e. [N+N]_N as coordinate type) and peripheral members who waver between two types (i.e. [A+N]_N as subordinate and attributive). Other peripheral members are those that have multiple identities, with the latter identity rendered by diachronic change such as lexicalization (Brinton & Traugott 2005:35) or synchronic synchronic operations such as on-line

derivation (Zheng, 2012) or abbreviation⁵. However far the surface form of a compound deviates from the core of a category, it is unanimously agreed that one should base a decision on the underlying form when determining the internal structure of a compound. Consider the debatable case 义拍 *y ìpāi righteousness-auction* ‘charity auction’. Special attention should be given to the part of speech of the compound 义拍 *y ìpāi* and of the underlying parts in each expression in (7).

- (7) a. 第一阶段,义拍了十多幅作品。

D ìyī jiē-du àn, [y ìpāi]- le sh íduō-f ú zu ò-pǐn
The-first. step-stage, [charity-auction]-ASP. ten-more-CLASS. work-item.
‘*In the first stage, more than ten works have been charity-auctioned.*’

- b. 一场慈善义拍

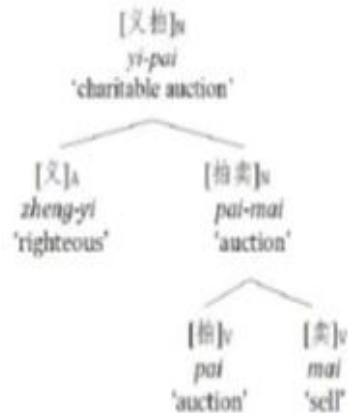
yī-chǎng c ísh àn [y ìpāi]
one-CLASS. kind-good. [charity-auction]
‘*a charity auction*’

In (7a), 义拍 *y ìpāi* charity-auction is used as a verb followed by a past aspectual particle *le*, which only attaches to predicates as a clitic. In (7b), 义拍 *y ìpāi* charity-auction is used as a noun modified by a quantifier phrase 一场 *yī-chǎng* one-ground ‘one’ and an adjective 慈善 *c ísh àn* charity-kind ‘charitable’. Looking into the property of the two constituents individually, 义拍 *y ìpāi* charity-auction can be divided four ways, as follows.

Figure 2.1 Different derivations for 义拍 *y ìpāi* charity-auction

⁵ Abbreviation or acronym is named as ‘metacompounding’ by Ceccagno and Basciano (2007). I hesitate to adopt this term given that this phenomenon has been named other way long before and widely discussed in isolate languages (Vietnamese; Chinese). It is considered a result of coercion under the Principle of Maximized Economy and the Principle of Maximized Expressive Power.

a.



b.



c.



d.



Ceccagno and Basciano (2007, henceforth C&B for short) cite this case as a metacompounding example to show surface-underlying inconsistency. For the same purpose, I cite this case in Figure 2.1 to show that their analysis is insufficient in deciding underlying forms. In their analysis, 义拍 is decomposed only in the manner of Figure 2.1(a). In other words, they judge that on the surface, its lexical category is noun. This judgment does not hold in expression (2.1a), where 义拍 is a verb. Even when treated simply as a noun, 义拍 can be analyzed in two ways, due to the dual identities of the

modifier lexeme 义 *yì* as an adjective (‘righteous’) as in Figure 2.1(a) and as a nominal (‘righteousness’) as in Figure 2.1(b). Along the vertical dimension, the differences between Figure 2.1(a&c) are the lexical category of the whole compound and of its right-hand constituent 拍. The behavior of 拍 *pāi* ‘auction’ in Chinese is exactly parallel to that in English, which can serve both as a verb and as a noun, although from the morphology, English *auction* contains a nominal suffix *-tion* and so may look more like noun to verb conversion, and Chinese 拍 *pāi* contains a hand-motion radical ‘手’ and so may look more like verb to noun conversion⁶. From an underlying point of view, 义拍 also has two forms, a nominal form and a verbal form. Accordingly, C&B infer that the inconsistency embodied in an underlying verbal compound has a nominal surface projection. This analysis is problematic in that they consider the V-to-N conversion as occurring in the maximal projection 义拍, charitable-auction; however, from the comparison of (2.1a) and (2.1b), it can be seen that in fact the V-to-N conversion occurs in the intermediate projection 拍卖 auction-sale, which is converted from a verb [[拍]_V[卖]_V]_V ‘to auction’ to a noun [[拍]_V[卖]_V]_N ‘(an) auction’. The property of the highest node 义拍 is simply the projection of the intermediate node. In other words, the morphology operation applies in the course of compounding, rather than after the completion of compounding. This accounts for the fact that no matter in what syntactic context it is presented, 义拍

⁶ Diachronic evidence plays an important role in deciding underlying form of a lexeme/compound. However this is not the concern of current discussion. Therefore, I will not look into the conversion process of any constituent. Consideration will only be given to its behavior in modern language.

charitable-auction can always be substituted by 拍卖 *auction-sale*. Compare expressions in (8) and (9).

- (8) a. 第一阶段,义拍了十多幅作品。

D ìyī jiē-du àn, [y ìpāi]- le sh íduō-f ú zu òpǐn
the-first. step-stage. [charity-auction]-ASP. ten-more.CLASS. work-item
'*In the first stage, more than ten works have been auctioned for charity.*'

- b. 一场慈善义拍

yī-chǎng c ísh àn [y ìpāi]
one-CLASS. kind-good. [charitable-auction]
'*a charity auction*'

- (9) a. 第一阶段,拍卖了十多幅作品。

D ìyī jiē-du àn, [pāi-m à]-le sh íduō-f ú zu òpǐn
the-first. step-stage. [auction]-ASP. ten-more-CLASS. work-item
'*In the first stage, more than ten works have been auctioned.*'

- b. 一场慈善拍卖

yī-chǎng c ísh àn [pāi-m à]
one-CLASS. kind-good. [auction]
'*a charitable auction*'

Notice that in (8b) and (9b), both nominal 义拍 y ìpāi charity-auctioncan and nominal 拍卖 pāi-m à auction-sale can be modified by the adjective 慈善 c ísh àn charitable-charitable 'charitable'. In precedence of 义拍 y ìpāi charity-auctioncan 'auction for charity', it renders itself semantic redundancy; while the redundancy is void when it modifies 拍卖 pāi-m à auction-sale 'auction'.

This surface-underlying inconsistency is successfully captured by Packard (2000: 194) through contrasting canonical head and virtual head from cognitive perspective, in which ‘canonical head is a hypothetical head by speakers processing’:

“The intuition behind the notion of ‘canonical head’ is that knowledge about the form class identity of a word’s internal constituents is, in the unmarked case, ‘driven’ by the gestalt word’s form class identity. This means that given a speaker’s knowledge of the form class of a word, there will exist a default value, or ‘hypothesis’, in the speaker’s grammar regarding the nature of the word’s internal constituents, specifically regarding the identity of the canonical head.”

A word’s ‘virtual’ head is a word constituent that simply means the syntactic determiner of the word. The pair of heads explains that the surface-underlying inconsistency is caused by language derivation and processing respectively on different stages. Despite the fact there is a sole underlying formation of 义拍 yìpāi charity-auction, speakers can still reanalyze the structure differently, according to the communicative context. The morphological process of assigning a canonical head imitates the process of zero derivation, both of which change the function of the structure without changing the surface forms. In other words, the canonical head is derived when the morphology completes the deep structure and sends it to perception.

By postulating ‘canonical head’, Packard (2000) also challenges the traditional methods of investigating headedness structures. Since language is users’ language and not linguists’ language, the structures of compound words should be determined by all the speakers in the community. Along with this logic, the prevailing head position is also decided by the speakers. This deduction pushes us to rethink the representativeness and

reliability of the materials that linguists have been using to examine the head positions and ask: is the head position indeterminate because we are looking in the wrong place? In the following section, an alternative method using data elicited from native speakers is put forward and discussed.

2.1.3 Textual material analyses of Chinese compound headedness

Within theoretical morphology models, word-formation argumentation comparison between constructions or between languages often relies on qualitative or quantitative analysis of textual data, such as dictionaries. This implies a certain risk that the lexical information compiled in dictionaries is limited, thus, not representative of the structures in question, or not representative of the morphology of target languages, or that the differences are due to factors other than morphological regulations. Conclusions drawn using the text-based approach also vary from one another. Huang (1998) proposes Chinese compound words are left-head dominant structures with a thorough review of the DSCs included in Contemporary Chinese Dictionary. Packard (2000) proposes that the canonical compound structures in native speaker cognition have two headedness values (hierarchical structures) that follow the Headedness Principle: verbs have their heads on the left and nouns have their heads on the right. In contrast, Ceccagno & Basciano (2007) argue based on a study of neologisms that both headed and non-headed/headless structures (flat structures) are equally productive in coining new compounds, suggesting that there is no one dominant structure in the native speaker's mental lexicon. Dong (2004) proposes that noun-modifier-noun-modified structure, such as 蜜蜂 mǐfēng honey-

bee ‘honeybee’, is the most productive structure in Chinese based on a computational linguistic project aiming to build up a generative compound data-base.

2.1.4 Methodologies

As were demonstrated, the data have played a crucial role in motivating headed-structure-dominant (Huang; Packard) and no-structure-dominant (Ceccagno & Basciano) accounts of Chinese compound structures and have been claimed to be representative of people’s mental lexicon. The common method of determining the headedness of Chinese compounds is to use textual sources such as dictionaries to compile quantitative information on the distribution of Chinese compound headedness. However, lexical information compiled from dictionaries is mainly selected from existing major media publications, such as newspaper articles, popular novels, broadcasting news and cyber news, etc. (Liang et al, 2013). The fact that the nature of those sources is limited to written language poses a reliability issue for dictionary-based approaches, since they may not correspond with the native speaker’s actual cognitive grammar despite the fact that previous studies do intend to investigate ‘the morphological competence of today’s speakers (C&B)’ and believe that “*there will exist a default value, or ‘hypothesis’, in the speaker’s grammar regarding the nature of the word’s internal constituents.....lexical information from native speakers’ brains* (Packard, 2000: 147)”.

In the following sections, two elicited production studies were conducted, concerning with the central issue of the headedness debate that whether there is a dominant head position existing in native speakers’ mental inventories. The rationale is that production data is more natural than text data and reflects native speakers’ intuitions

better. Systematically gathered intuitions are practical to confirm generalizations drawn from text sources. Schütze (1996) also suggests that the way intuitions are gathered also plays an important role considering that subconscious judgments can be affected by various factors. Experiment 1 required native speakers to recall a word list from working memory and was designed to gather elicited errors in order to reveal a default regular form, while Experiment 2 required another group of native speakers to freely produce disyllabic compounds in order to reveal native speakers' preferred form.

2.2 Experiment I

Design

Experiment I aimed to investigate whether there is a default headedness structure in native speakers' mental lexicon, and if there is, which structure it would be. If there are no dominant headedness patterns in native speakers' productions, the headed forms and non-head forms should be expected to be equally frequent, which yields the expected ratio of headed versus non-headed productions to be a 50/50 likelihood. Thus, we set the 50/50 percentage as the expected value, against which the observed values would be compared by likelihood ratio tests (uniformly the most powerful test).

Methods

In this experiment, a free-recall task was designed. Healey and Kahana (2014) evaluate different laboratory memory tasks that require participants to retrieve very specific information. They conclude that imposing strong constraints on the scope of memory search in, for example, serial recall, recognition or pair-associated tasks, allows

researchers to study specific memory processes while controlling other factors. In this free-recall task, a strong morpheme cue was imposed to examine the morphology retrieval process on one hand, and on the other hand, to provoke participants into employing a word-formation strategy when their retrieval processes encountered obstacles. The assumption was that there is a pre-stored formula of word formation in each native speaker's mental lexicon. Morpheme cues serve as variables following which participants would end up with more structures adhering to a given formula. The most common formula would then be considered the default structure of the compound word. With regard to this specific task, a word-formation strategy was assumed to be provoked by the requirement of recalling more words than normal working memory is capable of. In other words, when their memory fails, participants were to make up words with the given morpheme cues. What was investigated would be which word structure was more frequently used in their word-coining.

Materials

A free-recall word list consisting of 24 agriculture-related⁷ DSCs (two-syllable compounds) was constructed. Among the 24 words, 12 of them were parallel structure, which meant the form was constructed by two roots belonged to the same lexical category. This type of forms consisted of 4 nouns in the form of [N+N], 4 verbs in the form of [V+V] and 4 adjectives in the form of [A+A]. The other 12 were non-parallel forms consisting of 4 [A+N] nouns, 4 [V+N] verbs and 4 [A+V] verbs. Table 2.1 presents a complete list of 24 test items.

⁷ The purpose of choosing agricultural words was to avoid subject bias given that all participants were all raised in urban areas in China and all majoring in non-agriculture fields.

Table 2.1 Twenty-four test DSCs

Parallel forms				
N+N	秧芽	苗秧	芽种	苗种
V+V	种耕	播插	种播	耕插
A+A	直顺	优顺	顺逆	逆直
Non-parallel forms				
X+N	直芽	优种	逆种	顺秧
V+X	插苗	耕秧	播种	种苗
X+V	优种	直播	顺耕	逆插

The 24 DSCs were composed by 12 root morphemes (see Table 2.2), each of which repeatedly occurred four times in 4 different DSCs. The reoccurrence of the same morphemes decreased the distinctions between words and thus increased the difficulty of recalling the exact listed items on the one hand. On the other hand, when the type frequency of each root increased, they would serve as word-formation sources and facilitate the participants to coin unlisted DSCs when their recall failed. Only the unlisted DSCs were regarded as the elicited productions in this study.

Table 2.2 The root morphemes

Noun	Verb	Adjective
枝	耕	直
干	种	顺
秧	插	逆
苗	播	优

Notice that because we wanted to make sure each root was repeated four times, we cannot at the same time ensure that all items are established words, which is to say that NOT all 24 test items in Table 2.2 are established words that can be found in a dictionary. We considered it as a minor defect because we were not expecting the listed items to be recalled, so the familiarity and frequency of a form are not considered key factors to the

design. On the contrary, more unlisted coinages were desired. Using non-words, however, was infeasible in the study because we wanted to balance the test item in the way that the headed forms and the non-headed forms are equal in number. Given that only when a form has a transparent form-meaning pattern can its internal headedness structure be determined, efforts were made to maximize the naturalness and interpretability of the test items if they were not selected from dictionaries but made by the experimenters.

Participants and procedure

11 Chinese graduate students in Beijing Language and Culture University (BLCU) participated in the study with 5 USD as compensation. All participants took the test at the same time in a classroom equipped with PC monitor screens. They were instructed that they would see and hear a list of 24 words from a computer-controlled monitor. The words were read by a female native speaker speaking Beijing Putonghua (standard Mandarin) and recorded by recording software Audacity 2.1.1 on a Dell personal computer in a phonetics lab in BLCU. The audio record was played only once synchronously with the visual presentation in the fashion that one word occurred immediately after the previous one disappeared, with 100ms interval in between the two words. After the presentation, participants were required to recall at least 20 words in any order they wanted and provide a brief definition for each word in order for the experimenter to identify the internal structures of their productions. A session began with a six-item practice list, followed by the full experimental list. The whole experiment session lasted 20 minutes.

Results and discussion

We extracted the unlisted items which were made by the participants rather than recalled. Based on their definitions, the production was determined as either a headed or a non-headed form⁸. Table 2.3 presents the count and ratio (%) of each type of forms produced by the 11 participants.

Table 2.3 Unlisted item distributions

Subject	Total	Unlisted total	Headed		Non-headed		Expected
	counts	counts	counts (%)		counts (%)		
1	15	6	5	(83)	1	(17)	3
2	17	5	4	(80)	1	(20)	2.5
3	15	3	3	(10)	0	(0)	1.5
4	14	6	5	(83)	1	(17)	3
5	16	14	10	(71)	4	(29)	7
6	18	3	3	(100)	0	(0)	1.5
7	20	8	6	(75)	2	(25)	4
8	15	8	5	(63)	3	(38)	4
9	20	8	6	(75)	2	(25)	4
10	17	3	3	(100)	0	(0)	1.5
11	20	14	13	(93)	1	(7)	7
Total	187	78	63		15		39

In the binomial test, a null hypothesis and an alternative hypothesis were proposed regarding the possibilities of getting the two forms. If the result is significant, we must reject the null hypothesis and if the result is insignificant, we must accept the null hypothesis.

1) Null hypothesis (H₀): the possibilities of getting two forms are equal; if

calculated in one side, the headed forms take up 50% of the total production (H₀:

p-headed=0.5);

⁸ Very few productions were derivational forms, such as 种子 zhǒng-zǐ seed-zǐ 'seed'; and they were excluded.

2) **Alternative hypothesis (H_A): the possibilities of getting two forms are not equal**; if calculated in one side, the headed form's ratio is larger (or smaller) than 50% ($H_A: p\text{-headed} \geq 0.5$).

The 63 headed observations among the 78 total observations elicited from the 11 subjects follow binomial distribution with parameters with $H_0: p\text{-headed} = .5$ and $H_A: p\text{-headed} \geq .5$, ($\sum \text{Headed}_{11} \sim \text{binomial}(78, 0.5)$). A likelihood ratio test was run by R; the result showed a significant difference, $p < 0.000$. Due to the significant p value, we must reject the null hypothesis and accept the alternative hypothesis, which says that the two forms are not equal in number. From Table 2.9, it can be seen that NSs coined more headed forms than nonheaded forms, both being compared to the expected 50% possibility.

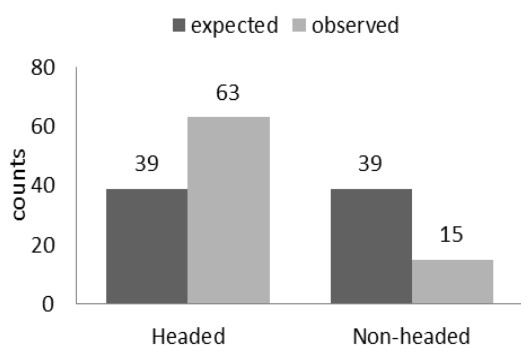
Table 2.4 Exp. counts vs. Obs. counts

	Observed	Expected	Row Totals
Headed	63	39	102
Non-headed	15	39	54
Column Totals	78	78	156 (Grand Total)

Base on Table 2.4, in this test, 11 subjects wrongfully recalled 78 unlisted disyllabic forms in total and the headed form came up 63 times. According to the makeup of the free recall list, we would expect the headed forms to come up $78 * 0.5 = 39$ times. The question is to find out whether the proportion of the observed headed forms significantly higher than would be expected? A binomial test was used; the binomial distribution $B(78, 0.5)$ to calculate the probability of 63 or more headed forms in a sample of 78 if the true probability of getting a headed form on each trial is 0.5. In this case, the probability of that is $p < 0.000$. This result suggests there is significant difference between the observed

headed forms and the expected headed forms. In other words, the elicited errors indicated that the two forms may not be evenly prominent in NSs' mental representations. Headed forms may be more prevalent a pattern to Chinese L1 speakers. Figure 2.2 illustrates the asymmetric distribution of the two forms in observations.

Figure 2.2 Differentials between Exp. and Obs.



The results suggest that native speakers either believe that they heard more headed forms or believe that the headed forms are a more convenient compounding pattern when compared with the non-headed form. Either case would suggest that the headed forms may be prevalent in Chinese.

2.3 Experiment II

Experiment 2 was a timed word formation task, which was designed to investigate the headedness structure of Chinese compound words and whether this structure has a parallel mental representation in native speakers' mental lexicon.

Design

Following the postulation of emergent grammar, the quality of the input determines the quality of the output; thus we assumed that if a dominant headed pattern were found

in the language, it would also be found in native speakers' productions. To test this hypothesis, we used a set of root morphemes, first to establish an all-possible-word pool judged by a panel of 10 Chinese lexicographers; second to elicit compound word productions from 10 non-linguist Chinese native speakers. Then the numbers of the headed/nonheaded productions were compared with those of the all-possible-words by a series of binomial tests.

Methods

In a set time period, participants were asked to make up compounds by using two root morphemes among a selection of morphemes in a morpheme bank. Previous studies on lexical production proposed that there may be three factors potentially affecting self-monitoring in the process of lexical production; they are lexical sensitivity, context effects, and time pressure (Dhooge & Hartsuiker, 2012; Dell, 1986; Levelt et. al, 1999; Oomen & Postma, 2001). In this experiment, we attempted to minimize the lexical sensitivity and the context effects on the one hand, and on the other control the time course in order to decrease the possibility of self-correction. The rationale is that people would provide the most convenient answer to the question when the self-monitoring system is inactive. Specifically speaking, we assumed that the very first coinage that occurs to participants' minds when seeing the morphemes would be what they feel more comfortable using or what they use more often in daily speech; and thus can be considered as their mental representations of language.

Materials and participants

The same 12 agriculture-related root morphemes used in Experiment 1 were reused in Experiment 2 (repeated in Table 2.5). In this experiment, 10 Chinese graduate students (5 female; 5 male; mean age=27.5) from an American university were recruited and offered 5 USD for their time. Given that they were all raised in urban households and majoring in non-agriculture fields, we regarded this set of morphemes having lower lexical sensitivity to the subjects.

Table 2.5 Morpheme bank

Noun	Verb	Adjective
枝	耕	直
干	种	顺
秧	插	逆
苗	播	优

The morphemes were printed in SimHei 15 and displayed in a 3 by 4 table on a sheet of paper (see Table 2.6). Each line contained one nominal, one verbal and one adjectival root. To decrease the context effects, we made sure that any two adjacent roots in either the vertical or horizontal dimension cannot form an established word.

Table 2.6 Test material display

枝	优	播
种	插	顺
直	耕	干
苗	逆	秧

First, exhausting the 12 root morphemes gave us 132 ($12^2=132$) disyllabic forms. Then a panel of 10 Chinese lexicographers (either being a PhD student or a professor in Chinese lexicography) was organized to determine among the 132 forms, which ones

were possible compound words in Chinese (even being not dictionary-listed). A questionnaire consisting of the 132 potential forms plus another 132 disyllabic real words (as fillers) was constructed and given to the 10 lexicographers. They were asked to rate each form using a 1~5 scoring system, with 5 representing ‘the most possible’ words in Chinese and 1 representing ‘the least possible’ words in Chinese. They were also asked to provide a definition for each word they rated higher than 3. Based on the ratings, 23 out of the 132 forms that were rated higher than the median 3 (including 3) were determined as the all possible words (presented in Table 2.7). Next, according to the provided definitions, 6 out of the 23 (26%) were non-headed forms and 17 out of 23 (73%) were headed forms. This makeup is consistent with Zhou (1999)’s report on the basis of the dictionary’s data, in which, 25.7% are parallel forms (non-headed forms) and 67% are headed forms⁹. We regarded the 26/73 ratio as the makeup two types of compound forms in Chinese, and it also served as the expected value against which the elicited productions would be compared.

Table 2.7 All-possible-word pool

Type	Structure		Sub-total count (%)	Total count (%)
Headed	[V _H +N] _V	插苗 种秧 种苗 播种 插秧	5 (22)	17 (73)
	[A+N _H] _N	干枝 直苗 直枝 直干 优干	5 (22)	
	[A+V _H] _V	直播 优耕 直插 逆插 顺插 插种 插播	7 (30)	
Non-headed	[N+N] _N	枝干 秧苗 苗秧	3 (13)	6 (27)
	[V+V] _V	耕种	1 (4)	
	[A+A] _A	顺逆 顺直	2 (9)	

⁹ In Zhou’s classifications, duplicative forms (重叠格) such as 妈妈 mā-mā mother-mother were also included in the compound words, taking up 0.8% of the total. Duplicative forms are more often considered as derived words; thus were not included the current study.

Procedure

In the word formation task, the 10 subjects took the test individually. They were instructed that they would see a table containing 12 single words on a sheet. They would choose any two words from the table to coin a complex word. In three minutes, they would write down as many words as they could and provide a brief meaning for each word on the answer sheet. They were also instructed that the words should be either real words or made-up words with reasonable meanings. A training session using four morphemes was conducted, followed by a full-list session.

Results and discussion

The produced forms were classified into the two types headed and non-headed. According to the expected value 27/73, the expected numbers of the non-headed forms for each subject were calculated. Table 2.8 presents the elicited number and ratio (%) of the non-headed forms and the expected number of the non-headed forms.

Table 2.8 Exp. vs. Obs. of the two forms

Subject	Total	Headed		Non-headed			
		Observed counts (%)		Expected	Observed counts (%)		Expected
<i>1</i>	12	9	(75)	8.76	3	(25)	3.24
<i>2</i>	18	17	(94)	13.14	1	(6)	4.86
<i>3</i>	18	13	(72)	13.14	5	(28)	4.86
<i>4</i>	16	11	(69)	11.68	5	(31)	4.32
<i>5</i>	14	12	(86)	10.22	2	(14)	3.78
<i>6</i>	18	14	(78)	13.14	4	(22)	4.86
<i>7</i>	17	13	(76)	12.41	4	(24)	4.59
<i>8</i>	21	15	(71)	15.33	6	(29)	5.67
<i>9</i>	15	10	(67)	10.95	5	(33)	4.05
<i>10</i>	18	15	(83)	13.14	3	(17)	4.86
Total	167	129		121.91	38		45.09

In the binomial test, two hypotheses—a null hypothesis and an alternative hypothesis—regarding the makeups of the observed and the expected forms were proposed. If the result is significant, we must reject the null hypothesis and if the result is insignificant, we must accept the null hypothesis.

1) **Null hypothesis (H_0): the observed makeup of the two forms should not be different from the expected makeup of the two forms;** if calculated in one side, the headed forms take up 73% of the total production (H_0 : $p\text{-headed}=0.73$);

2) **Alternative hypothesis (H_A): the observed makeup of the two forms should be different from the expected makeup of the two forms;** if calculated in one side, the headed form's ratio is larger than 73% (H_A : $p\text{-headed}\geq 0.73$).

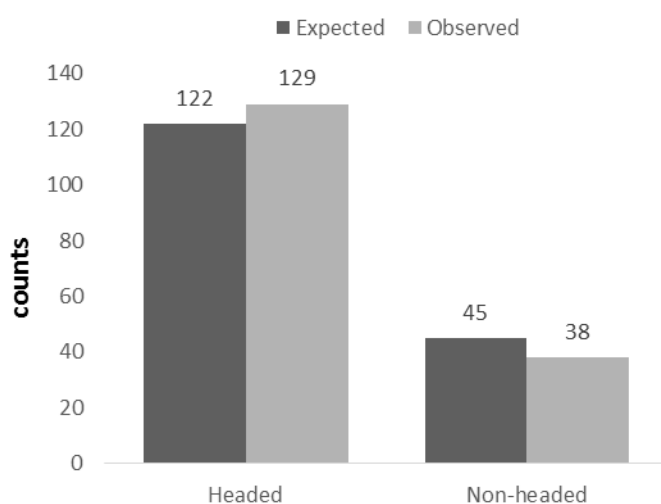
The 129 headed observations among the 167 total observations elicited from the 10 subjects follow binomial distribution with parameters with H_0 : $p\text{-headed}=.73$ and H_A : $p\text{-headed}\geq .73$), ($\sum \text{Headed}_{10} \sim \text{binomial}(167, 0.73)$). A likelihood ratio test was run in R; the result showed an insignificant difference, $p>0.999$. The insignificant p value leads us to accept the null hypothesis, which says the observed makeup of the two forms are no different from the expected makeup which headed forms taking up 73% of the total productions and the non-headed forms taking up 27% of the total productions. Table 2.9 presents the total productions and the total expectations of each type.

Table 2.9 Exp. counts vs. Obs. counts

	Observed	Expected	Row Totals
Headed	129	122	251
Non-headed	38	45	83
<i>Column Totals</i>	<i>167</i>	<i>167</i>	<i>334 (Grand Total)</i>

Base on Table 2.9, in this test, 10 subjects produced 167 disyllabic forms in total and the headed form came up 129 times. According to the makeup found in the all-possible-word pool (73% headed vs. 27% non-headed), we would expect the headed forms to come up $167 \times 0.73 = 121.91$ times. A binomial test was run by R to compare the proportion of the observed headed forms to that of the expected headed forms. A binomial distribution $B(167, 0.73)$ calculated the probability of 129 or more headed forms in a sample of 169 if the true probability of getting a headed form on each trial is 73%. In this case, the probability of that is $p=0.107$. This result indicates an insignificant difference between the observed proportion and the expected proportion of the headed forms. In other words, we must assume that the elicited productions matched the expectation. Figure 2.3 illustrates the parallelisms between the observations and the expectations.

Figure 2.3 Differentials between the Exp. vs. Obs. of the two forms



The result suggested that native speakers' lexical knowledge to a large extent overlaps with the distribution of the existing words. In other words, what forms are to be

coined or retrieved is determined by what forms have already established or pre-stored. This result supports the concept of emergent grammar (Hopper & Martin, 1987; Bybee, 2006), which postulates that the rules of grammar emerge as language forms are used.

2.4 Summary

In this chapter, a small-scope study was conducted to test the headedness patterns of Chinese compounding morphology. Results from two elicited production tasks imply that native speakers are likely to offer more headed forms than non-headed forms, which supports the hypothesis that the headed forms are prevalent (Packard, 2000) in Chinese. In addition, the ratio of the headed/nonheaded forms demonstrated in the elicited data was also found to be consistent with the makeup of the possible-word pool and the percentages of the dictionary data calculated by Zhou (1999). This finding provides support for the tenets of emergent grammar, which postulates that quality of the language outputs is determined by the quality of the inputs. In this case, the quality of the inputs can also indicate the productivity of particular morphemes, meaning how many and what kind(s) of compound words those morphemes can construct. From here, we may also advance a generalization that the morphological productivities of language forms have corresponding mental representations in native speakers' word formation component.

Chapter III Conclusion

3.1 Summary

To summarize this work, I restate the fundamental theory behind the experimental approaches: language is a cognitive system. Arguing about the identity and language status of a particular construction could be more significant and convincing, if the postulations and the empirical data are consistent with the language behaviors unconsciously manipulated by language users, as is proposed in the work on Chinese morphology by Packard (2000: 2):

“Following current trends in cognitive science, I shall argue that much of what native speakers know about words and their structure occurs innately in the form of a hard-wired, specifically linguistic ‘program’ in the brain, and that such hard-wired word structure information is realized in surface form upon exposure to linguistic data. Following that line of reasoning, Chinese words are worth investigating because they have the potential to tell us a great deal about the universal properties of words in natural language.”

In our opinion, this generalization applies to the multi-word constructions as well. We could furthermore argue that native speakers’ mental representations of linguistic material would function to verify or falsify the theoretical hypotheses of the universal properties of a specific construction in natural language. The psycholinguistic experiments in this work demonstrated the consistency and inconsistency between theoretical hypotheses and the native speakers’ language behaviors.

The first experiments on the processing of the VCCs suggest that the VCC may be a

pre-fabricated template in native speakers' mental lexicons, given the findings that a VCC form is processed faster than a non-VCC form. This result on one hand agrees with the postulation of the Construction Grammar/Morphology. On the other hand, the correlation between the VCC and processing speed was merely found in three-syllabic VCCs, which also points out a problem of 'the innate template' hypothesis: that the outcomes of the VCC template cannot be infinitely long; only those whose lengths are similar to words or formulaic chunks may be assumed to be formed directly through the template; otherwise, due to the insignificant effect of verb repetition on processing speed, longer VCC instances should be attributed to the outcome of syntactic operations. However, the formation of the VCC template per se should be attributed to the generative principles because native speakers also demonstrated a significantly directional linking of the two verbs of the VCC (from lower copy to higher copy but not *vice versa*), which coincides with the postulated derivations of the Copy Merge Theory of Movement.

The second experiments on productions of disyllabic root-compounding words regarding the 'head' versus 'non-head' forms suggest that in native speakers' mental lexicons the dominant structure of compounding morphology is the headed structure as opposed to the non-headed structure. The elicited productions of the two forms also suggest the makeup of the headed/nonheaded forms in native speakers' mental inventories is consistent with the makeup of the two forms in all existing disyllabic compound words. The results confirm the reasoning of usage-based grammar and more specifically the 'emergentist model' that people's mental lexicons are built from language experience. Thus, there should be considerable consistency between the outcomes and the inputs.

In conclusion, should the psycholinguistic methods we used in this work be valid, the findings serve as evidence for the following assumptions: i) the syntax and mental lexicon are functioning cooperatively in shaping the Internal language (the template) and producing the Externalized language (individual instance); ii) the quality of the language outputs is determined by the quality of the inputs; thus language acquisition may start from storing concrete instances to generalize abstract rules and then to coin infinite expressions. This deduction can also be seen as a defense of the ‘poverty of the stimulus’ argument.

3.2 Limitations

In the current study, some *post hoc* findings may help shed light on the processing and acquisition of the MWCs in future studies.

Firstly, regarding the VCC experiments, the position of the V-O-V sequence in a sentence, in other words, the pre-VOV sequence was not included as a predictor to the processing speed of the V-O-V. Previous findings suggested that sentence comprehension is an incremental process (Kamide, Altmann & Haywood; 2003), which means language parsers do not wait until to the end to start processing the whole sentence, but comprehend the fragments as the sentence is unfolding (Frazier, 1987; Pickering & Traxler, 1998). Therefore, the length and the complexity of the pre-VOV sequence may affect the processing speed in different directions. Longer pre-VOV sequences cause more burden to working memory thus bringing in a negative effect on the one hand, and on the other hand, the lexical semantic information incorporated in the pre-VOV sequence may facilitate the prediction of the coming V-O-V thus introducing in a positive

effect. These contextual factors deserve a finer control if the intention is to investigate the interactions between the MWCs and its surrounding elements.

Secondly, in the DSC experiments, the same methods deserve replication using lexical stimuli selected from different sources. For instance, instead of using any particular discipline to avoid familiarity effect (such as agriculture in the current study), we can use words or morphemes of relatively low frequencies or low productabilities to elicit errors or new coinages. Besides, in order to further test the correspondence between the existing DSCs and the NSs' mental representations, we can classify the naturally produced DSCs into different sub-categories; then compare the elicited sub-categories to those generalized by linguists; or compare the ratio of a certain sub-category of DSCs to the dictionary ratio of it.

In the end, I propose that the Chinese MWC is an abundant yet under-explored resource that bears revisiting. Psycholinguistic literature has showed us that there are many investigating tools to use for testing the well-argued theories. This venue is especially significant and to some extent necessary when the implication of the theoretical account is language acquisition-oriented.

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APPENDIX

Appendix A.1 Test materials of Experiment I (Chapter 1)

A is a V_H -empty sentence; B is a V_L -empty sentence.
 V_H and V_L are in bold.

-
- 1 A 他__那个常年没人住的房间**打扫**了一整天。
 B 他**打扫**那个常年没人住的房间__了一整天。
- 2 A 他__英语考试**准备**了一下午。
 B 他**准备**英语考试__了一下午。
- 3 A 他__电脑**玩**了一个晚上。
 B 他**玩**电脑__了一个晚上。
- 4 A 他__马**骑**了三个小时。
 B 他**骑马**__了三个小时。
- 5 A 他__一顿饭**吃**了半天。
 B 他**吃**一顿饭__了半天。
- 6 A 他__那两篇论文**看**了一个周末。
 B 他**看**那两篇论文__了一个周末。
- 7 A 他__黄山**爬**了两天。
 B 他**爬**黄山__了两天。
- 8 A 他__试**考**了好几十分钟。
 B 他**考试**__了好几十分钟。
- 9 A 他__名山大川**游历**了好几年。
 B 他**游历**名山大川__了好几年。
- 10 A 他__自己心仪的车子**找**了大半年。
 B 他**找**自己心仪的车子__了大半年
-

Appendix A.2 Test materials of Experiment II (Chapter 1)

A is a non-VCC sentence; B is a VCC sentence.

The number after A/B indicates the syllable number of the O-V sequence.

V_H and V_L are in bold; proper nouns are underlined.

Average MI of V-Os in A condition = 5.206; average MI of V-Os in B condition = 1.842

Average stroke of V-Os in A condition = 11.55; average stroke of V-Os in B condition = 10.65

-
- 1 A2 他**练**马**骑**了\一整天\屁股都**磨**起了\水泡。
 B2 他**练**马**练**了\一整天\屁股都**磨**起了\水泡。
- 2 A3 他女朋友**试**衣服**换**了\十几件\也没看上一件。

- B3 他女朋友\试\衣服试了\十几件\也没看上一件。
- 3 A3 他打电话\订\外卖叫了\一个肯德基全家桶。
B3 他打电话\订\外卖订了\一个肯德基全家桶。
- 4 A3 他最近\跑\业务忙得\昏天暗地。
B3 他最近\跑\业务跑得\昏天暗地。
- 5 A3 35岁以后\她\相\对象谈了\不下十位\却都没有\相中的。
B3 35岁以后\她\谈\对象谈了\不下十位\却都没有\相中的。
- 6 A3 为了结婚\他俩\选\房子找了\大半年。
B3 为了结婚\他俩\选\房子选了\大半年。
- 7 A3 他\为了\给孩子\办转学\走\关系找到了\领导的岳父家。
B3 他\为了\给孩子\办转学\走\关系走到了\领导的岳父家。
- 8 A3 他为了\照顾妹妹\念\大学读了\省内的学校。
B3 他为了\照顾妹妹\念\大学念了\省内的学校。
- 9 A3 他们\游\长城登了\八达岭\和慕田峪。
B3 他们\游\长城游了\八达岭\和慕田峪。
- 10 A3 她\喂\孩子哄了\半个多小时\孩子才吃完。
B3 她\喂\孩子喂了\半个多小时\孩子才吃完。
- 11 A3 这几年\他下海\搞\装潢做得\很红火。
B3 这几年\他下海\搞\装潢搞得\很红火。
- 12 A3 他们\爬\黄山游了\一个周末\很尽兴。
B3 他们\爬\黄山爬了\一个周末\很尽兴。
- 13 A4 他们火速\转移\伤员救助了\一百多人。
B4 他们火速\转移\伤员转移了\一百多人。
- 14 A4 专家们\集思广益\论证\问题讨论了\一个下午。
B4 专家们\集思广益\论证\问题论证了\一个下午。
- 15 A4 他\复习\考试准备了\三个通宵。
B4 他\复习\考试复习了\三个通宵。
- 16 A4 地震后\他亲自\走访\群众帮助了\很多受灾地区。
B4 地震后\他亲自\走访\群众走访了\很多受灾地区。
- 17 A4 早些年\读\张爱玲看得\并不仔细。
B4 早些年\读\张爱玲读得\并不仔细。
- 18 A4 生日晚会后\妈妈\整理\餐具擦洗了\一个晚上。

- B4 生日晚会后\妈妈\整理\餐具\整理了\一个晚上。
- 19 A5 他\打\电脑游戏玩得\入了迷。
- B5 他\打\电脑游戏打得\入了迷。
- 20 A5 他\记\英语单词背了\100 遍\也没记住。
- B5 他\记\英语单词记了\100 遍\也没记住。
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